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VOLTAGE CONTROL FOR CAPACTIVE MAT

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VOLTAGE CONTROL FOR CAPACITIVE MAT

BACKGROUND

Various kinds of imaging apparatuses that are configured to form images on sheet media are known. Some such apparatuses form images on sheet media in correspondence to an electronic document file, commonly referred to as a print job. Other types of imaging apparatus perform their imaging function in response to optically scanning an image-bearing sheet media. Thus, examples of imaging apparatuses include laser printers, inkjet printers, thermal imaging devices, photocopiers, etc.

Generally, such imaging apparatuses temporarily secure the sheet media in a registered relationship with an imaging engine (i.e., inkjet print head, etc.) during the image forming process so as to achieve the desired image placement on the media. One kind of device used to temporarily secure sheet media is the capacitive mat. Broadly speaking, capacitive mat devices typically include a number of electrically charged conductors, usually arranged as a grid or matrix within a layer of nonconductive material, to support a sheet of media in registered orientation by way of capacitive (i.e., electrostatic) attraction.

One generally undesirable aspect of capacitive mats is the tendency for the layer of nonconductive material to develop a residual electrostatic charge (known as polarization) over the course of operative time. This polarization tends to reduce the efficiency or 'holding power' of the capacitive mat with respect to the supported sheet media. Such loss of holding power can lead to movement and/or mis-registration of the sheet media supported by the capacitive mat during operation, resulting in undesirable or unacceptable imaging quality or media jams thereon.

Therefore, it is desirable to provide methods and apparatus for use with capacitive mats that address the polarization problems discussed above.

SUMMARY

One embodiment of the present invention provides a sheet media support apparatus, including a capacitive mat including electrical first and second nodes. The capacitive mat is configured to electrically attractingly support a sheet media. The apparatus further includes a controller, which is coupled to the first and second nodes of the capacitive mat. The controller is configured to selectively electrically energize the first node at a first predetermined potential in response to an input, and to wait for a first predetermined period of time. The controller is also configured to electrically energize

1 the second node at a second predetermined potential after the first predetermined period
2 of time.

3 Another embodiment of the present invention provides for a sheet media support
4 apparatus, including a capacitive mat. The capacitive mat includes electrical first and
5 second nodes, and is configured to electrically attractingly support a sheet media. The
6 apparatus further includes a controller coupled to the first and second nodes of the
7 capacitive mat. The controller is, in turn, configured to selectively electrically energize
8 the first node at a time-increasing positive potential in response to an input, and to
9 electrically energize the second node at a time-increasing negative potential
10 contemporaneous with the energizing the first node.

11 Still another embodiment of the present invention provides a sheet media support
12 apparatus, including a capacitive mat including electrical first and second nodes. The
13 capacitive mat is configured to electrically attractingly support a sheet media. The
14 apparatus also includes a controller coupled to the first and second nodes of the
15 capacitive mat. The controller is configured to selectively electrically energize the first
16 node at a first predetermined positive potential, and to electrically energize the second
17 node at a first predetermined negative potential in response to an input. The controller is
18 further configured to wait for a first predetermined period of time, and to electrically
19 energize the first node at a second predetermined positive potential and electrically
20 energize the second node at a second predetermined negative potential after the first
21 predetermined period of time.

22 Yet another embodiment provides for a method of controlling a capacitive mat,
23 the method including receiving an input, and electrically energizing a first node of the
24 capacitive mat at a first predetermined potential. The method further includes waiting for
25 a first predetermined period of time, and electrically energizing a second node of the
26 capacitive mat after the first predetermined period of time.

27 These and other aspects and embodiments will now be described in detail with
28 reference to the accompanying drawings, wherein:

29

30 DESCRIPTION OF THE DRAWINGS

31 Fig. 1 is a side elevation sectional view depicting a capacitive mat according to
32 the prior art.

33 Fig. 2 is a block diagram depicting an imaging apparatus in accordance with an
34 embodiment of the present invention.

1 Fig. 3 is a perspective view depicting a capacitive mat in accordance with another
2 embodiment of the present invention.

3 Fig. 4 is a perspective view depicting a capacitive mat in accordance with yet
4 another embodiment of the present invention.

5 Fig. 5 is a signal timing diagram in accordance with still another embodiment of
6 the present invention.

7 Fig. 6 is a signal timing diagram in accordance with another embodiment of the
8 present invention.

9 Fig. 7 is a signal timing diagram in accordance with yet another embodiment of
10 the present invention.

11 Fig. 8 is a flowchart depicting a method in accordance with still another
12 embodiment of the present invention.

13 Fig. 9 is a flowchart depicting a method in accordance with another embodiment
14 of the present invention.

15 Fig. 10 is a flowchart depicting a method in accordance with yet another
16 embodiment of the present invention.

17

DETAILED DESCRIPTION

18 In representative embodiments, the present teachings provide methods and
19 apparatus for controlling a capacitive mat suitable for the registered support of a sheet
20 media, typically within an imaging apparatus. In general, such methods of the present
21 invention utilize any number of suitable sequences or signal patterns for energizing a
22 capacitive mat and typically include such characteristics as one or more step changes in
23 electrical potential, linear and/or non-linear ramping of (i.e., time-varying) electrical
24 potential, or any suitable combination of these or other electrical energization
25 characteristics. Such methods and apparatus of the present invention provide for the
26 substantial elimination of the polarization problems described above.

27 Turning now to Fig. 1, a side elevation sectional view depicts a capacitive mat 50
28 according to the prior art. The capacitive mat 50 includes a non-conductive base
29 material (i.e., substrate) 52. As depicted in Fig. 1, the substrate 52 supports a plurality
30 of generally positive conductors 54 and a plurality of generally negative conductors 56.
31 The positive conductors 54 and the negative conductors 56 are assumed to extend away
32 from the viewer, and are alternately arranged so as to generally define an inter-digitated,
33 conductive grid or matrix on the substrate 52. The pluralities of conductors 54 and 56

1 are electrically coupled to respective positive and negative electrical connections on a
2 grid control circuit 58.

3 The capacitive mat 50 further includes a non-conductive (i.e., dielectric) cover
4 material 60 that overlies and substantially encapsulates the pluralities of conductors 54
5 and 56 in generally fixed relationship with one another, the substrate 52, and the cover
6 material 60. In this way, the positive conductors 54 and the negative conductors 56 are
7 substantially isolated against contact with entities outside of the capacitive mat 50 (with
8 the exception of electrical coupling to the grid control circuit 58). Further depicted in
9 Fig. 1 is a sheet of media 62, which is generally supported on a surface 64 defined by
10 the cover material 60.

11 Typical operation of the capacitive mat 50 is as follows: to begin, it is assumed
12 that the sheet of media 62 is deposited (i.e., delivered) in resting support on the surface
13 64 of the capacitive mat 64 by way of a suitable delivery mechanism (not shown). The
14 grid control circuit 58 then electrically energizes the positive conductors 54 and the
15 negative conductors 56 such that a generally constant, predetermined electrical potential
16 exists between these two respective pluralities.

17 The electric field corresponding to the energized pluralities of conductors 54 and
18 56 causes a corresponding migration of electrical charge within the sheet media 62,
19 such that regions of positive charge 66 generally accumulate within the sheet media 62
20 over each of the negative electrodes 56, while regions of negative charge 68 generally
21 accumulate over each of the positive electrodes 54. As a result, a capacitive
22 (electrostatic) hold-down or 'tacking' force is exerted on the sheet media 62, which
23 serves to support the sheet media 62 in a substantially registered orientation with
24 respect to the capacitive mat 50 and/or other entities (not shown).

25 Eventually, the need to hold-down or register the sheet media 62 with the respect
26 to the capacitive mat 50 ends. At such time, the grid control circuit 58 de-energizes the
27 positive conductors 54 and the negative conductors 56, resulting in the substantial
28 release of the sheet media 62.

29 Over the course of time, the capacitive mat 50, electrostatic charges (not shown)
30 tend to accumulate within the dielectric cover material 60. This charge accumulation
31 within the cover material 60 is referred to as polarization. These polarization charges
32 (not shown) generally mimic those that are induced within the sheet media 62 and are
33 opposite the charges of the conductors 54 and 56 during operation.

34 The polarization charges tend to oppose the accumulation of the charges 66 and
35 68, thus resulting in a general decreasing of the tacking or hold-down force exerted on

1 the sheet media 62 by the capacitive mat 50. If the magnitude of the polarization
2 becomes too severe, the hold-down force can become insufficient to maintain proper
3 registration of the sheet media 62 during imaging or other associated operations.
4 Undesirable degradation in imaging quality, media jams, or media crashing into the pens
5 can, in turn, result.

6 Methods and apparatus of the present invention, described hereafter, address
7 this problem.

8 Fig. 2 is a block diagram depicting an imaging apparatus 100 in accordance with
9 an embodiment of the present invention. The imaging apparatus 100 includes an
10 imaging apparatus controller (hereafter, controller) 102. The controller 102 can typically
11 include any controller suitable for controlling typical normal operation of the imaging
12 apparatus 100. As such, the controller 102 can include, for example: a microprocessor
13 or microcontroller; a solid-state memory or other computer-accessible storage media; a
14 state machine; digital, analog, and/or hybrid electronic circuitry; sensing instrumentation;
15 etc. One of skill in the electronic control arts can appreciate that various embodiments
16 of the controller 102 can be used in correspondence with differing embodiments of the
17 imaging apparatus 100 and that further elaboration is not required for an understanding
18 of the present invention.

19 The imaging apparatus 100 also includes an imaging engine 104. The imaging
20 engine 104 is generally coupled in controlled relationship with the controller 102. The
21 imaging engine 104 can be defined by any such imaging engine suitable for selectively
22 forming images on sheet media "S" (described in detail hereafter) under the control of
23 the controller 102. For example, the controller 104 can include an inkjet imaging engine,
24 etc. Other suitable embodiments of the imaging engine 104 can also be used.

25 The imaging apparatus 100 also includes a capacitive mat 106. The capacitive
26 mat 106 can be generally defined by any capacitive mat suitable for use with the present
27 invention. The capacitive mat 106 is generally configured to controllably support a sheet
28 media S in registered orientation with the imaging engine 104 (or other suitable elements
29 of the imaging apparatus 100, not shown) during normal operation. The capacitive mat
30 106 is configured to provide such registered support of the sheet media S by way of
31 electrical (i.e., capacitive, or electrostatic) attraction under the control of a mat controller
32 108 (described hereafter). Further elaboration of the capacitive mat 106 is provided
33 hereafter.

34 The imaging apparatus 100 further includes the mat controller 108 of the present
35 invention introduced above. The mat controller 108 can include any electronic circuitry

1 suitable for electrically coupling the capacitive mat 106 to a source or sources of
2 electrical energy (not shown) under the control signal influence of the controller 102 and
3 in accordance with the methods of the present invention. Thus, the mat controller 108
4 can include, for example: digital, analog and/or hybrid electronic circuitry; signal
5 amplifying circuitry; electrical switching devices; a microprocessor or microcontroller;
6 etc.; or any combination of these or other suitable circuit elements. It can be
7 appreciated by one of skill in the electrical arts that varying embodiments of the mat
8 controller 108 can be used in accordance with the present invention, and that more
9 particular elaboration is not required for purposes herein. It will also be appreciated that
10 the mat controller 108 can be provided by components within the imaging apparatus
11 controller 102, described above.

12 It is to be understood that the imaging apparatus 100 also typically includes other
13 elements and devices not specifically shown in Fig. 2. Such other elements can include,
14 for example: an electrical energy source or sources; an operator interface; input/output
15 circuitry; optical scanning devices; sheet media transport and routing mechanisms; etc.
16 These and other elements and devices can be selectively included in varying
17 embodiments of the imaging apparatus 100 as required or desired for typical respective
18 operation thereof.

19 Normal operation of the imaging apparatus 100 is generally as follows: the
20 controller 102, in response to receiving an electronic document file (not shown), causes
21 sheet media S to be drawn from an input tray 110 and routed to the capacitive mat 106.
22 The controller 102 then causes the mat controller 108 to energize (i.e., electrically
23 couple an energy source or sources to) the capacitive mat 106 in accordance with the
24 methods of the present invention. Energizing of the capacitive mat 106 by way of the
25 mat controller 108 generally results in the capacitive (i.e., electrostatic) attraction of the
26 sheet media S into supported registration with the imaging engine 104. This capacitive
27 attraction is generally referred to as hold-down or tacking force.

28 The controller 102 then causes the imaging engine 104 to selectively form
29 images on the registered, supported sheet media S in accordance with the electronic
30 document file. The controller 102 thereafter causes the mat controller 108 to de-energize
31 the capacitive mat 106, effectively halting the capacitive attraction between the imaged
32 sheet media S and the capacitive mat 106. The controller 102 then causes the imaged
33 sheet media S to be suitably transported generally out of the imaging apparatus 100.

1 The process described above is typically repeated, one sheet of media S at a
2 time, until the electronic document file has been completely imaged on the sheet media
3 S. The imaged sheet or sheets of media generally define an imaged document 112.

4 Because the capacitive mat 106 is controlled in accordance with the methods of
5 the present invention (described in detail hereafter), the polarization effect described
6 above in regard to the capacitive mat 50 of Fig. 1 is substantially negated. Thus, the
7 capacitive mat 106, under the influence of the mat controller 108, exerts a substantially
8 controllable, non-degrading hold-down (tacking) force upon sheets of media S over the
9 course of its useful life.

10 Fig. 3 is a perspective view depicting a capacitive mat 206 in accordance with
11 another embodiment of the present invention. The capacitive mat 206 can be used as
12 the capacitive mat 106 of Fig. 2. The capacitive mat 206 includes a non-conductive (i.e.,
13 dielectric) substrate 220. The substrate 220 can be formed from any suitable dielectric
14 material, such as, for example, plastic, glass, silicon dioxide, etc. Other materials can
15 also be used to form the substrate 220.

16 The capacitive mat 206 also includes a plurality of positive conductors 222, and a
17 plurality of negative conductors 224. Each of the positive conductors 222 and the
18 negative conductors 224 can be formed from any suitable electrically conductive
19 material. Non-limiting examples of such electrically conductive material include copper,
20 silver, conductively doped semiconductor, etc. Other suitable electrically conductive
21 materials can also be used.

22 As depicted in Fig. 3, the positive conductors 222 are arranged in alternating,
23 spaced, parallel placement with the negative conductors 224, such that a grid or matrix
24 is defined and supported by the substrate 220. Each of the plurality of positive
25 conductors 222 is electrically coupled to one another so as to define a single positive
26 node 230. Similarly, each of the plurality of negative conductors 224 is electrically
27 coupled to one another to define a single negative node 232. Each of the positive
28 conductors 222 and the negative conductors 224 extends substantially across a
29 widthwise dimension "W" of the capacitive mat 206. Furthermore, the particular count of
30 positive conductors 222 and negative conductors 224 can vary selectively as desired in
31 correspondence with different embodiments (not shown) of the capacitive mat 206.

32 The capacitive mat 206 further includes a dielectric cover material 226. The
33 dielectric cover material can be formed from any suitable electrically non-conductive
34 material such as, for example, plastic, glass, silicon dioxide, etc. Other suitable
35 materials can also be used to form the cover material 226. The cover material 226 is

1 configured to cooperate with the substrate 220 such that the positive conductors 222
2 and the negative conductors 224 are substantially encapsulated and isolated against
3 physical contact with entities outside of the capacitive mat 206. The cover material 226
4 is further configured to define a substantially planar support surface 228.

5 Further depicted in Fig. 3 is a mat controller 208. The mat controller 208 is
6 electrically coupled to the positive node 230 and the negative node 232 of the capacitive
7 mat 206. The mat controller 208 can be defined by suitable mat controller in accordance
8 with the present invention such as, for example, the mat controller 108 of Fig. 2. Thus,
9 the mat controller 208 is generally configured to selectively energize the positive node
10 230 and the negative node 232 of the capacitive mat 206 in response to an appropriate
11 input or signal, typically from an imaging apparatus controller (not shown, see the
12 controller 102 of Fig. 2), in accordance with the methods of the present invention.

13 Typical operation of the capacitive mat 206 is generally as described above in
14 regard to the capacitive mat 106 of Fig. 2. In this way, the capacitive mat 206 is
15 generally configured to controllably exert an electrostatic hold-down force on a sheet of
16 media (not shown) so as to maintain such a sheet of media in supportive registration
17 during imaging operations within an imaging apparatus (not shown, see the imaging
18 apparatus 100 of Fig. 2.).

19 Fig. 4 is perspective view depicting a capacitive mat 306 in accordance with yet
20 another embodiment of the present invention. The capacitive mat 306 includes a
21 dielectric core or substrate 320. The substrate 320 can be formed from any suitable
22 non-conductive material such as, for example, plastic, glass, silicon dioxide, etc. Other
23 materials suitable for forming substrate 320 can also be used. As depicted in Fig. 4, the
24 substrate 320 substantially defines a hollow cylinder. Other suitable geometries can
25 also be used.

26 The capacitive mat 306 also includes a plurality of positive conductors 322, and a
27 plurality of negative conductors 324. Each of the positive conductors 322 and the
28 negative conductors 324 can be formed from any suitable electrically conductive
29 material. Non-limiting examples of such electrically conductive material include copper,
30 silver, conductively doped semiconductor, etc. Other suitable electrically conductive
31 materials can also be used.

32 As shown in Fig. 4, the positive conductors 322 are arranged in alternating,
33 spaced, parallel placement with the negative conductors 324, such that a grid or matrix
34 is defined and supported by an outer surface of the generally cylindrical substrate 320.
35 In this way, substantially one-half of the substrate 320 outer surface area is utilized to

1 support the positive conductors 322 and the negative conductors 324. In another
2 embodiment (not shown), a greater or lesser fraction of the substrate 320 outer surface
3 area can be used to support conductors 322 and 324. In such an embodiment (not
4 shown), the count of positive conductors 322 and negative conductors 324 can also vary
5 selectively.

6 In any case, each of the plurality of positive conductors 322 is electrically coupled
7 to one another so as to define a single positive node 330. Similarly, each of the plurality
8 of negative conductors 324 is electrically coupled to one another to define a single
9 negative node 332. Each of the positive conductors 322 and the negative conductors
10 324 extends substantially across a lengthwise dimension "L" of the capacitive mat 306.

11 The capacitive mat 306 further includes a dielectric cover material 326. The
12 dielectric cover material can be formed from any suitable electrically non-conductive
13 material such as, for example, plastic, glass, silicon dioxide, etc. Other suitable
14 materials can also be used to form the cover material 326. The cover material 326 is
15 configured to cooperate with the substrate 320 such that the positive conductors 322
16 and the negative conductors 324 are substantially encapsulated and isolated against
17 physical contact with entities other than the capacitive mat 306. The cover material 326
18 is further configured to define a substantially flat, smooth, generally cylindrical support
19 surface 328, in accordance with the geometry of the substrate (i.e., core) 320.

20 Further depicted in Fig. 4 is a mat controller 308. The mat controller 308 is
21 electrically coupled to the positive node 330 and the negative node 332 of the capacitive
22 mat 306. The mat controller 308 can be defined by suitable mat controller in accordance
23 with the present invention such as, for example, the mat controller 108 of Fig. 2. Thus,
24 the mat controller 308 is generally configured to selectively energize the positive node
25 330 and the negative node 332 of the capacitive mat 206 in response to an appropriate
26 input or signal, typically from an imaging apparatus controller (not shown, see the
27 controller 102 of Fig. 2), in accordance with the methods of the present invention.

28 Typical operation of the capacitive mat 306 is substantially as described above in
29 regard to the capacitive mat 106 of Fig. 2. However, in contrast to the substantially
30 planar geometry of the capacitive mat 206 of Fig. 3, the capacitive mat 306
31 electrostatically supports a sheet media (not shown) on the support surface 328 in a
32 correspondingly arced or curved registration thereon. This arced registration of the
33 supported sheet media (not shown) is generally desirable in some usage environments
34 such as, for example, during the deposition of imaging media (not shown) onto the
35 supported sheet media within a inkjet printer type of imaging apparatus (not shown, see

1 the imaging apparatus 100 of Fig. 2). Other usage environments call for corresponding
2 embodiments of capacitive mat (not shown) that include support surface geometries
3 conducive to the particular environment.

4 Fig. 5 is a signal timing diagram (hereafter, timing diagram) 400 in accordance
5 with still another embodiment of the present invention. The timing diagram 400 depicts
6 energization signals (described hereafter) for controllably operating a capacitive mat,
7 such as, for example, the capacitive mats 106, 206 and 306 of respective Figs. 2, 3
8 and 4, in accordance with the present invention. The energization signals of the timing
9 diagram 400 are typically provided (i.e., generated or coupled) to a capacitive mat of the
10 present invention by way of a mat controller of the present invention such as, for
11 example, the mat controllers 108, 208 and 308 of respective Figs. 2, 3 and 4.

12 The timing diagram 400 includes a ground reference potential line 402. The
13 ground reference potential 402 is any suitable electrical potential or datum from which
14 other relevant signals of the timing diagram 400 are referenced. For purposes herein,
15 the ground reference potential 402 is considered a zero energy level or electrically
16 de-energized state.

17 The timing diagram 400 also includes an electrical positive node signal 404. The
18 positive node signal 404 is typically coupled to a positive node of a capacitive mat (e.g.,
19 positive node 230 of Fig. 3) of the present invention. The timing diagram 400 further
20 includes an electrical negative node signal 406. The negative node signal 406 is
21 typically coupled to a negative node of a capacitive mat (e.g., negative node 232 of
22 Fig. 3) of the present invention.

23 Normal operation under the timing diagram 400 is as follows: the positive node
24 signal 404 is electrically energized from ground reference potential 402 to a
25 predetermined positive potential 408 at a time "T0". The positive node signal 404 is
26 substantially maintained at this positive potential 408 for a first predetermined period of
27 time "P1" – that is, the period of time P1 can be considered as a wait or "dwell" period.

28 Thereafter, at a time "T1", the negative node signal 406 is electrically energized
29 from ground reference potential 402 to a predetermined negative potential 410. The
30 positive node potential 404 and the negative node potential 410 are then respectively
31 maintained during a second predetermined wait or dwell period of time "P2".

32 Thereafter, at a time "T2", both the positive node signal 404 and the negative
33 node signal 406 are substantially simultaneously electrically de-energized, typically by
34 coupling both respective signals 404 and 406 to ground reference potential 402. At this

1 point, one energization cycle or iteration of the timing diagram 400 is considered
2 complete.

3 The timing diagram 400 provides one method of energizing a capacitive mat (i.e.,
4 capacitive mats 106, 206, 306 of respective Figs. 2, 3 and 4) in accordance with the
5 present invention. In this way, the shifts in energization of the positive node signal 404
6 and negative node signal 406 that occur at times T0, T1 and T2, respectively, tend to
7 permit an increase of the charge levels occurring on the capacitive mat, with a
8 corresponding increased (i.e., generally sufficient) hold down force, even when some
9 degree of polarization occurs.

10 Fig. 6 is a signal timing diagram (hereafter, timing diagram) 500 in accordance
11 with another embodiment of the present invention. The timing diagram 500 includes a
12 ground reference potential line 502, substantially as described above in regard to the
13 ground reference potential line 402 of Fig. 5. Thus, the ground reference potential line
14 502 is considered a zero-energy reference level or datum within the context of the timing
15 diagram 500.

16 The timing diagram 500 also includes an electrical positive node signal 504. The
17 positive node signal 504 is generally coupled to a positive node of a capacitive mat (e.g.,
18 positive node 230 of Fig. 3) of the present invention. The timing diagram 500 also
19 includes an electrical negative node signal 506. The negative node signal 506 is
20 typically coupled to a negative node of a capacitive mat (e.g., negative node 232 of
21 Fig. 3) of the present invention.

22 Normal operation under the timing diagram 500 is as follows: the positive node
23 signal 504 and the negative node signal 506 are substantially simultaneously electrically
24 energized to predetermined initial positive and negative potentials 512 and 514,
25 respectively, at time "T0'".

26 Thereafter, the positive node signal 506 assumes a substantially linear,
27 time-increasing positive potential 508 for a predetermined time period "P1'". Also, the
28 negative node signal 506 assumes a substantially linear, time-increasing negative
29 potential 510 for the predetermined time period P1'. Thus, the respective electrical
30 potentials of the positive node signal 504 and the negative node signal 506 are
31 time-changing in a generally contemporaneous, mirror-image fashion with respect to the
32 ground reference potential line 502.

33 Then, at a time "T1' ", both the positive node signal 504 and the negative node
34 signal 506 are substantially simultaneously electrically de-energized. Generally, this can
35 be accomplished by coupling both respective signals 504 and 506 to ground reference

1 potential 502. At this point, a single iteration of the timing diagram 500 is considered
2 complete.

3 The timing diagram 500 provides a method of energizing a capacitive mat (i.e.,
4 the capacitive mats 106, 206, 306 of respective Figs. 2, 3 and 4) in accordance with
5 another embodiment of the present invention. The respective time-increasing electrical
6 potentials of the positive node signal 504 and negative node signal 506 tend to
7 substantially reduce the undesirable effects of polarization as described above. That is,
8 generally sufficient hold down force results in accordance with the method as depicted
9 by the timing diagram 500.

10 Fig. 7 is a signal timing diagram (hereafter, timing diagram) 600 in accordance
11 with yet another embodiment of the present invention. The timing diagram 600 includes
12 a ground reference potential line 602 substantially as described above in regard to the
13 ground reference potential line 402 of Fig. 5.

14 The timing diagram 600 also includes an electrical positive node signal 604. The
15 positive node signal 604 is typically coupled to a positive node of a capacitive mat (e.g.,
16 positive node 230 of Fig. 3) of the present invention. The timing diagram 600 also
17 includes an electrical negative node signal 606. The negative node signal 606 is
18 typically coupled to a negative node of a capacitive mat (e.g., negative node 232 of
19 Fig. 3) of the present invention.

20 Normal operation under the timing diagram 600 is as follows: at an initial time
21 "T0" ", the positive node signal 604 is electrically energized to a first predetermined
22 positive potential 608. Contemporaneously, the negative node signal 606 is electrically
23 energized to a first predetermined negative potential 610. Both the first predetermined
24 positive potential 608 and the second predetermined negative potential 610 are
25 maintained at substantially constant respective levels during a first predetermined time
26 period (i.e., wait, or dwell period) "P1" ".

27 Thereafter, at a time "T1" ", the positive node signal 604 is electrically energized
28 (i.e., elevated) to a second predetermined positive potential 612, and the negative node
29 signal 606 is electrically energized to a second predetermined negative potential 614.
30 The second predetermined potentials 612 and 614 are respectively maintained during a
31 second predetermined time period "P2" ".

32 Then, at a later time "T2" ", both the positive node signal 604 and the negative
33 node signal 606 are substantially simultaneously de-energized. Such de-energization is
34 typically accomplished by coupling both the positive node signal 604 and the negative

1 node signal 606 to ground reference potential 602. At such a time, a single instance or
2 iteration of the timing diagram 600 is considered complete.

3 The timing diagram 600 provides a method of energizing a capacitive mat (i.e.,
4 capacitive mats 106, 206, 306 of respective Figs. 2, 3 and 4) in accordance with yet
5 another embodiment of the present invention. The respective changes in the electrical
6 potential of the positive node signal 604 and negative node signal 606 at times T0", T1"
7 and T2" serve to substantially mitigate the undesirable effects of any polarization which
8 may occur within the dielectric cover material (such as, for example, the dielectric cover
9 material 226 of Fig. 3) of the particular capacitive mat controlled under the energization
10 signal method described by the timing diagram 600.

11 Each of the timing diagrams 400, 500 and 600 described above provides (i.e.,
12 depicts) an energization signal method or format of the present invention for use with a
13 capacitive mat (such as the capacitive mats 106, 206, 306 of respective Figs. 2, 3
14 and 4). Furthermore, each of the energization signal methods described in the timing
15 diagrams 400, 500 and 600 can be implemented by way of a suitable embodiment of
16 mat controller of the present invention, such as the mat controllers 108, 208, 308 of
17 respective Figs. 2, 3 and 4.

18 In this way, the present invention provides a number of suitable control method
19 (i.e., energization signal) embodiments for use in the registration and support of sheet
20 media on a capacitive mat. It is to be understood that other embodiments of the present
21 invention that correspond to other signal timing diagrams (not shown) for use with
22 capacitive mats are also possible within the scope of the present invention.

23 Such other embodiments of the present invention can include any suitable
24 combination of the capacitive mat energization characteristics described above in regard
25 to those of the timing diagrams 400, 500 and 600, including, for example, step changes
26 and/or time variations in electrical potential. Some of the embodiments of the present
27 invention are further described in the context of sequential methodologies hereafter.

28 Fig. 8 is a flowchart depicting a method 700 of controlling a capacitive mat in
29 accordance with still another embodiment of the present invention. For clarity, the
30 method 700 is described with reference to the imaging apparatus 100 of Fig. 2 and the
31 capacitive mat 206 of Fig. 3. It is to be understood, however, that the method 700 can
32 be suitably used in conjunction with other embodiments of the present invention.

33 In step 702 (Fig. 8), it is assumed that a sheet of media S (Fig. 2) is brought into
34 resting support on the capacitive mat 106.

1 In step 704 (Fig. 8), the mat controller 108 (Fig. 2) receives a hold-down (or
2 tacking) signal from the imaging apparatus controller 102.

3 In step 706 (Fig. 8), the mat controller 108 (Fig. 2) responds to the hold-down
4 signal and energizes the first node 222 (Fig. 3) of the capacitive mat 106 (Fig. 2) at a
5 predetermined positive potential or level.

6 In step 708 (Fig. 8), the mat controller 108 (Fig. 2) continues to energize the first
7 node 222 (Fig. 3) as established in step 706 (Fig. 8) above during a first wait or dwell
8 period.

9 In step 710 (Fig. 8), the mat controller 108 (Fig. 2) energizes a second node 224
10 (Fig. 3) of the capacitive mat 106 (Fig. 2) at a predetermined negative potential.

11 In step 712 (Fig. 8), the mat controller 108 (Fig. 2) continues to energize both the
12 first node 222 (Fig. 3) and the second node 224 as established in steps 706 (Fig. 8) and
13 710 above during a second predetermined wait period.

14 In step 714 (Fig. 8), the mat controller 108 (Fig. 2) de-energizes both the first
15 node 222 (Fig. 3) and the second node 224 of the capacitive mat 106 (Fig. 2). Typically,
16 this is done by coupling the nodes 222 (Fig. 3) and 224 to a ground reference potential.
17 In any case, the method 700 is now considered complete.

18 Fig. 9 is a flowchart depicting a method 800 of controlling a capacitive mat in
19 accordance with still another embodiment of the present invention. In the interest of
20 clarity, the method 800 is also described with reference to the imaging apparatus 100 of
21 Fig. 2 and the capacitive mat 206 of Fig. 3. It is to be understood, however, that the
22 method 800 can be suitably used in conjunction with other embodiments of the present
23 invention.

24 In step 802 (Fig. 9), a sheet of media S (Fig. 2) is assumed to be brought into
25 resting support with the capacitive mat 106.

26 In step 804 (Fig. 9), the mat controller 108 (Fig. 2) receives a hold-down signal
27 from the imaging apparatus controller 102.

28 In step 806 (Fig. 9), the mat controller 108 (Fig. 2) responds to the hold-down
29 signal by simultaneously energizing the first node 222 (Fig. 3) and the second node 224
30 of the capacitive mat 106 (Fig. 2) with respective first predetermined electrical potentials,
31 with the first node 222 (Fig. 3) potential being positive relative to that of the second node
32 224. Immediately thereafter, the mat controller 108 (Fig. 2) applies a time-increasing
33 potential difference to the nodes 222 (Fig. 3) and 224. This application of time-
34 increasing potential difference is continued by the mat controller 108 (Fig. 2) for a
35 predetermined period of time.

1 In step 808 (Fig. 9), the mat controller 108 (Fig 2.) de-energizes both the first
2 node 222 (Fig. 3) and the second node 224 of the capacitive mat 106 (Fig. 2).
3 Generally, this is accomplished by coupling the nodes 222 (Fig. 3) and 224 to a ground
4 reference potential. The method 800 is now complete.

5 Fig. 10 is a flowchart depicting a method 900 in accordance with yet another
6 embodiment of the present invention. While the method 900 is described with reference
7 to the imaging apparatus 100 of Fig. 2 and the capacitive mat 206 of Fig. 3, it is to be
8 understood that the method 900 can be suitably used in conjunction with other
9 embodiments of the present invention.

10 In step 902 (Fig. 10), a sheet of media S (Fig. 2) is brought into resting support
11 on the capacitive mat 106.

12 In step 904 (Fig. 10), the mat controller 108 (Fig. 2) receives a hold-down signal
13 from the imaging apparatus controller 102.

14 In step 906 (Fig. 10), the mat controller 108 (Fig. 2) responds to the hold-down
15 signal by simultaneously energizing the first node 222 (Fig. 3) and the second node 224
16 of the capacitive mat 106 (Fig. 2) with respective first predetermined electrical potentials,
17 with the first node 222 (Fig. 3) potential being positive relative to that of the second node
18 224.

19 In step 908 (Fig. 10), the mat controller 108 (Fig. 2) waits for a first predetermined
20 period of time. During this time the respective energization levels of the first node 222
21 (Fig. 3) and the second node 224 are substantially maintained as established in step 906
22 (Fig 10) above.

23 In step 910 (Fig. 10), the mat controller 108 (Fig. 2) simultaneously changes the
24 energization of the first node 222 (Fig. 3) and the second node 224 to second respective
25 predetermined potential levels. In this way, the electrical potential between the first node
26 222 and the second node 224 is typically increased relative to that established in step
27 906 (Fig. 10) above.

28 In step 912 (Fig. 10), the mat controller 108 (Fig. 2) waits for a second
29 predetermined period of time. During this time the respective energization levels of the
30 first node 222 (Fig. 3) and the second node 224 are maintained substantially as
31 established in step 910 (Fig. 10) above.

32 In step 914 (Fig. 10), the mat controller 108 (Fig 2.) de-energizes both the first
33 node 222 (Fig. 3) and the second node 224 of the capacitive mat 106 (Fig. 2). This is
34 usually accomplished by coupling the nodes 222 (Fig. 3) and 224 to a ground reference
35 potential. The method 900 is now considered to be complete.

1 While the methods 700, 800 and 900 of Figs. 8-10 above respectively describe
2 particular method steps and order of execution, it is to be understood that other methods
3 (not shown) consistent with other embodiments of the present invention can also be
4 used. Other such methods (not shown) can include suitable combinations of these or
5 other steps performed in correspondingly suitable orders of execution.

6 Thus, the present invention provides a number of methods and apparatuses that
7 are directed to substantially reducing polarization (i.e., electric charge accumulation)
8 within the dielectric cover material of the capacitive mat thus controlled. In this way, the
9 methods and apparatuses of the present invention provide for the ongoing controlled
10 operation of capacitive mats in a manner that is generally free from a loss of hold-down
11 or tacking force with respect to the supported sheet media.

12 While the above methods and apparatus have been described in language more
13 or less specific as to structural and methodical features, it is to be understood, however,
14 that they are not limited to the specific features shown and described, since the means
15 herein disclosed comprise preferred forms of putting the invention into effect. The
16 methods and apparatus are, therefore, claimed in any of their forms or modifications
17 within the proper scope of the appended claims appropriately interpreted in accordance
18 with the doctrine of equivalents.